CLAIMS

1. A lubricant injector (4) for injection of lubrication oil into the cylinder (1) of a large slow-running two-stroke engine; wherein the injector (4) comprises an injector housing (12) configured for being mounted in a cylinder wall (3) of the cylinder (1); the injector housing (12) comprising a nozzle tip (13) at one end of the injector housing (12) for reaching into the cylinder (1) when the injector housing (12) is mounted in the cylinder wall (3); wherein a nozzle (14) is provided in the nozzle tip (13), the nozzle (14) extending from an inner cavity (15) inside the injector housing (12) and through a wall (21) of the nozzle tip (13) for ejection of lubrication oil from the inner cavity (15) out of the injector housing (12) through the nozzle (14); wherein a valve member (16) is provided inside the injector housing (12), the valve member (16) being mounted reciprocal between an open and closed state of the injector (4); the valve member (16) sealingly covering the nozzle (14) when in the closed state for preventing access of lubrication oil to the nozzle (14), and the valve member (16) being movable away from the nozzle (14) during an open state for giving access of the lubrication oil from the inner cavity (15) to the nozzle (14) during an oil ejection phase; wherein

either,

A) the injector housing (12) comprises a plain bearing (23) with a first surface, and the valve member (16) comprises a stem (17) with a second surface, the second surface being provided slidably abutting the first surface in order for the stem (17) being reciprocally guided by the plain bearing (23) along a contact region (24) between the (17) stem and the plain bearing (23); wherein the valve member (16) comprises a valve needle (18) in coaxial longitudinal extension of the stem (17), the valve needle (18) comprising a needle tip (22) which is closing the nozzle (14) when abutting a cooperating valve seat (19) in the nozzle tip (13); wherein the first surface and the second surface are hardened surfaces;

or

B) the injector housing (12) comprises a cylindrical cavity part (15') with a first surface inside the nozzle tip (13), the nozzle (14) extending from the first surface through the wall (21) of the nozzle tip (13); wherein the valve member (16) comprises a cylindrical sealing head (25) with a second surface that is arranged slidably abutting

the first surface in order for the sealing head (25) to sealingly cover the nozzle (14) when in closed state; wherein for the first surface and the second surface are hardened surfaces.

2. An injector according to claim 1, wherein the hardness of the softest of the two surfaces deviates less than 10% from the hardness of the other surface.

3. An injector according to any preceding claim, wherein the hardest of the first and the second surface has a surface hardness according to Rockwell Hardness C of least 50.

4. An injector according to any preceding claim, wherein the first and the second surface are hardened steel surfaces.

5. An injector according to any one of the preceding claims, wherein the injector is a spray injector configured to eject lubrication oil as a spray when operated at a predetermined oil pressure level, which is a level within the interval of 25-100 bars.

6. An injector according to any one of the preceding claims, wherein the valve seat (19) comprises a hardened surface.

7. An injector according to claim 6, wherein the valve seat (19) has a surface hardness according to Rockwell Hardness C of least 50.

8. A lubricant injector (4) for injection of lubrication oil into the cylinder (1) of a large slow-running two-stroke engine; wherein the injector (4) comprises an injector housing (12) configured for being mounted in a cylinder wall (3) of the cylinder (1); the injector housing (12) comprising a nozzle tip (13) at one end of the injector housing (12) for reaching into the cylinder (1) when the injector housing (12) is mounted in the cylinder wall (3); wherein a nozzle (14) is provided in the nozzle tip (13), the nozzle (14) extending from an inner cavity (15) inside the injector housing (12) and through a wall (21) of the nozzle tip (13) for ejection of lubrication oil from the inner cavity (15) out of the injector housing (12) through the nozzle (14); wherein a valve

member (16) is provided inside the injector housing (12), the valve member (16) being mounted reciprocal between an open and closed state of the injector (4); the valve member (16) sealingly covering the nozzle (14) when in the closed state for preventing access of lubrication oil to the nozzle (14), and the valve member (16) being movable away from the nozzle (14) during an open state for giving access of the lubrication oil from the inner cavity (15) to the nozzle (14) during an oil ejection phase;

wherein the injector housing (12) comprises a plain bearing (23) with a first surface, and the valve member (16) comprises a stem (17) with a second surface, the second surface being provided slidably abutting the first surface in order for the stem (17) being reciprocally guided by the plain bearing (23) along a contact region (24) between the (17) stem and the plain bearing (23); wherein the valve member (16) comprises a valve needle (18) in coaxial longitudinal extension of the stem (17), the valve needle (18) comprising a needle tip (22) which is closing the nozzle (14) when abutting a cooperating valve seat (19) in the nozzle tip (13);

wherein the valve seat (19) comprises a hardened surface.

9. An injector according to claim 8, wherein the injector (4) is a spray injector configured to eject lubrication oil as a spray when operated at a predetermined oil pressure level, which is a level within the interval of 25-100 bars.

10. An injector according to claim 8 or 9, wherein the needle tip (22) is hardened or provided in a hard material that corresponds to the hardness of the hardened surface of the valve seat (19).

11. An injector according to anyone of the claims 8-10, wherein the valve seat (19) has a surface hardness according to Rockwell Hardness C of least 50.

12. An injector according to claim anyone of the claims 8-11, wherein the needle tip (22) for sealing cooperation with the valve seat comprises a conical end part of a cylindrical valve needle (18) or an end part that is tapering differently from a cone, or wherein the needle tip (22) comprises a ball (28).

13. A large slow-running two-stroke engine with a plurality of cylinders and a piston within each cylinder, the piston being reciprocal between two dead points; each cylinder having an ignition chamber for ignition of fuel; wherein at least three lubricant injectors (4) according to any one of the preceding claims are mounted along an inner circumference of each cylinder between the two dead points for lubrication of the cylinder wall in the ignition chamber.

14. An engine according to claim 13, wherein the engine is a marine engine.

15. An engine according to claim 13 or 14, wherein a lubrication oil pump and controller is provided which is connected to the injectors by lubrication supply lines, the lubrication oil pump configured for providing lubrication oil to the injectors at a predetermined oil pressure level, which is a level within the interval of 25-100 bars.

16. A method of achieving uniform long term performance among a plurality of identically produced lubricant injectors for a large slow-running two-stroke engine; wherein the injector (4) comprises an injector housing (12) mounted in a cylinder wall (3) of the cylinder (1); the injector housing (12) comprising a nozzle tip (13) at one end of the injector housing (12) reaching into the cylinder (1) when the injector housing (12) is mounted in the cylinder wall (3); wherein a nozzle (14) is provided in the nozzle tip (13), the nozzle (14) extending from an inner cavity (15) inside the injector housing (12) and through a wall (21) of the nozzle tip (13), the method comprising ejection of lubrication oil from the inner cavity (15) out of the injector housing (12) through the nozzle (14) during operation of the engine; wherein a valve member (16) is provided inside the injector housing (12), the valve member (16) being mounted reciprocal between an open and closed state of the injector (4); the valve member (16) sealingly covering the nozzle (14) when in the closed state for preventing access of lubrication oil to the nozzle (14), and the valve member (16) being movable away from the nozzle (14) during an open state for giving access of the lubrication oil from the inner cavity (15) to the nozzle (14) during an oil ejection phase; wherein either

A) the injector housing (12) comprises a plain bearing (23) with a first surface, and the valve member (16) comprises a stem (17) with a second surface, the second surface being provided slidably abutting the first surface in order for the stem (17)

being reciprocally guided by the plain bearing (23) along a contact region (24) between the (17) stem and the plain bearing (23); wherein the valve member (16) comprises a valve needle (18) in coaxial longitudinal extension of the stem (17), the valve needle (18) comprising a needle tip (22) which is closing the nozzle (14) when abutting a cooperating valve seat (19) in the nozzle tip (13);

or

B) the injector housing (12) comprises a cylindrical cavity part (15') with a first surface inside the nozzle tip (13), the nozzle (14) extending from the first surface through the wall (21) of the nozzle tip (13); wherein the valve member (16) comprises a cylindrical sealing head (25) with a second surface that is arranged slidably abutting the first surface in order for the sealing head (25) to sealingly cover the nozzle (14) when in closed state;

wherein the method comprises, during production of the injectors, hardening for the first surface and the second surface.

17. A method according to claim 16, wherein the hardest of the first and the second surface has a surface hardness according to Rockwell Hardness C of least 50.

18. A method according to claim 16 or claim 17, wherein the method comprises providing the surfaces as steel surfaces and hardening the steel surfaces.

19. A method according to claim 18, wherein the method comprises hardening the steel surfaces by carbonitriding.

20. A method according to claim 19, wherein the method comprises hardening the steel surfaces by austenitic carbonitriding at a temperature of 850 °C in a gas atmosphere to which were added between 0.5 and 0.8 % carbon and between 0.2 and 0.4% nitrogen.

21. A method according any one of the claims 16-20, wherein the method comprises hardening the valve seat.

22. A method of achieving uniform long term performance among a plurality of identically produced lubricant injectors for a large slow-running two-stroke engine; wherein the lubricant injector (4) comprises an injector housing (12) configured for being mounted in a cylinder wall (3) of the cylinder (1); the injector housing (12) comprising a nozzle tip (13) at one end of the injector housing (12) for reaching into the cylinder (1) when the injector housing (12) is mounted in the cylinder wall (3); wherein a nozzle (14) is provided in the nozzle tip (13), the nozzle (14) extending from an inner cavity (15) inside the injector housing (12) and through a wall (21) of the nozzle tip (13), and wherein the method comprises ejection of lubrication oil from the inner cavity (15) out of the injector housing (12) through the nozzle (14) during operation of the engine; wherein a valve member (16) is provided inside the injector housing (12), the valve member (16) being mounted reciprocal between an open and closed state of the injector (4); the valve member (16) sealingly covering the nozzle (14) when in the closed state for preventing access of lubrication oil to the nozzle (14), and the valve member (16) being movable away from the nozzle (14) during an open state for giving access of the lubrication oil from the inner cavity (15) to the nozzle (14) during an oil ejection phase; wherein

the injector housing (12) comprises a plain bearing (23) with a first surface, and the valve member (16) comprises a stem (17) with a second surface, the second surface being provided slidably abutting the first surface in order for the stem (17) being reciprocally guided by the plain bearing (23) along a contact region (24) between the (17) stem and the plain bearing (23); wherein the valve member (16) comprises a valve needle (18) in coaxial longitudinal extension of the stem (17), the valve needle (18) comprising a needle tip (22) which is closing the nozzle (14) when abutting a cooperating valve seat (19) in the nozzle tip (13);

wherein the method comprises hardening the valve seat (19).

23. A method according to claim 22, wherein the method comprises providing the valve seat as a steel surface and hardening the steel surface by carbonitriding.

24. A method according to claim 23, wherein the method comprises hardening the steel surfaces by austenitic carbonitriding at a temperature of 850 °C in a gas at-

mosphere to which were added between 0.5 and 0.8 % carbon and between 0.2 and 0.4 % nitrogen.

25. Use of surface-hardening for achieving uniform long term performance among a plurality of identical lubricant injectors for a large slow-running two-stroke engine; wherein for each injector, the injector (4) comprises an injector housing (12) configured for being mounted in a cylinder wall (3) of the cylinder (1); the injector housing (12) comprising a nozzle tip (13) at one end of the injector housing (12) for reaching into the cylinder (1) when the injector housing (12) is mounted in the cylinder wall (3); wherein a nozzle (14) is provided in the nozzle tip (13), the nozzle (14) extending from an inner cavity (15) inside the injector housing (12) and through a wall (21) of the nozzle tip (13) for ejection of lubrication oil from the inner cavity (15) out of the injector housing (12) through the nozzle (14); wherein a valve member (16) is provided inside the injector housing (12), the valve member (16) being mounted reciprocal between an open and closed state of the injector (4); the valve member (16) sealingly covering the nozzle (14) when in the closed state for preventing access of lubrication oil to the nozzle (14), and the valve member (16) being movable away from the nozzle (14) during an open state for giving access of the lubrication oil from the inner cavity (15) to the nozzle (14) during an oil ejection phase; wherein either

A) the injector housing (12) comprises a plain bearing (23) with a first surface, and the valve member (16) comprises a stem (17) with a second surface, the second surface being provided slidably abutting the first surface in order for the stem (17) being reciprocally guided by the plain bearing (23) along a contact region (24) between the (17) stem and the plain bearing (23); wherein the valve member (16) comprises a valve needle (18) in coaxial longitudinal extension of the stem (17), the valve needle (18) comprising a needle tip (22) which is closing the nozzle (14) when abutting a cooperating valve seat (19) in the nozzle tip (13);

or

B) the injector housing (12) comprises a cylindrical cavity part (15') with a first surface inside the nozzle tip (13), the nozzle (14) extending from the first surface through the wall (21) of the nozzle tip (13); wherein the valve member (16) comprises a cylindrical sealing head (25) with a second surface that is arranged slidably abutting

the first surface in order for the sealing head (25) to sealingly cover the nozzle (14) when in closed state;

wherein the surface-hardening comprises, during production of the injectors, hardening of the first surface and the second.

26. Use according to claim 25, wherein the hardest of the first and the second surface has a surface hardness according to Rockwell Hardness C of least 50.

27. Use according to claim 25 or 26, wherein the method comprises hardening the valve seat.

28. Use of surface-hardening for achieving uniform long term performance among a plurality of identical lubricant injectors for a large slow-running two-stroke engine; wherein for each injector, the injector (4) comprises an injector housing (12) configured for being mounted in a cylinder wall (3) of the cylinder (1); the injector housing (12) comprising a nozzle tip (13) at one end of the injector housing (12) for reaching into the cylinder (1) when the injector housing (12) is mounted in the cylinder wall (3); wherein a nozzle (14) is provided in the nozzle tip (13), the nozzle (14) extending from an inner cavity (15) inside the injector housing (12) and through a wall (21) of the nozzle tip (13) for ejection of lubrication oil from the inner cavity (15) out of the injector housing (12) through the nozzle (14); wherein a valve member (16) is provided inside the injector housing (12), the valve member (16) being mounted reciprocal between an open and closed state of the injector (4); the valve member (16) sealingly covering the nozzle (14) when in the closed state for preventing access of lubrication oil to the nozzle (14), and the valve member (16) being movable away from the nozzle (14) during an open state for giving access of the lubrication oil from the inner cavity (15) to the nozzle (14) during an oil ejection phase; wherein

the injector housing (12) comprises a plain bearing (23) with a first surface, and the valve member (16) comprises a stem (17) with a second surface, the second surface being provided slidably abutting the first surface in order for the stem (17) being reciprocally guided by the plain bearing (23) along a contact region (24) between the (17) stem and the plain bearing (23); wherein the valve member (16) comprises a valve needle (18) in coaxial longitudinal extension of the stem (17), the valve

needle (18) comprising a needle tip (22) which is closing the nozzle (14) when abutting a cooperating valve seat (19) in the nozzle tip (13);

wherein the surface-hardening comprises, during production of the injectors, hardening of the valve seat (19).

29. Use of a plurality of injectors according to anyone of the claims 1-12 for lubrication of a large slow-running two-stroke engine with a plurality of cylinders (2) and a piston within each cylinder (2), the piston being reciprocal between two dead points; each cylinder (2) having an ignition chamber for ignition of fuel; wherein at least three of the plurality of injectors (4) are mounted along an inner circumference of each cylinder between the two dead points for lubrication of the cylinder wall (3) in the ignition chamber.

30. Use according to claim 29, wherein the engine is a marine engine.

31. Use according to claim 29 or 30, wherein the engine comprises a lubrication oil pump and controller (11) which is connected to the injectors (4) by lubrication supply lines (9), wherein the injectors (4) are provided with lubrication oil at a predetermined oil pressure level, which is a level within the interval of 25-100 bars and used for providing a spray of lubrication oil.